



Agricultural Research Institute, Pusa

---

Description of a New Species of Tapeworm  
*Dipylidium catus*, n. sp.

with

A Note on the Genus *Dipylidium* Leuckart  
1863

BY

AMAR NATH GULATI, M.Sc.

*Imperial Institute of Veterinary Research, Muktesar*

(Now Microscopist, Cotton Technological Research Laboratory, Matunga,  
Bombay)



CALCUTTA: GOVERNMENT OF INDIA  
CENTRAL PUBLICATION BRANCH

1929

Price, As. 6 or 8d.

**Government of India Publications are obtainable from the Government of  
India Central Publication Branch, 3, Government Place, West,  
Calcutta, and from the following Agents :—**

**EUROPE.**

OFFICE OF THE HIGH COMMISSIONER FOR INDIA, 42, GROSVENOR GARDENS, LONDON, S.W.1.  
And at all Booksellers.

**INDIA AND CEYLON.**

**Provincial Book Depôts :**

**MADRAS:**—Superintendent, Government Press, Mount Road, Madras.  
**BOMBAY:**—Superintendent, Government Book Depot, Town Hall, Bombay.  
**SIND:**—Library attached to the Office of the Commissioner in Sind, Karachi.  
**BENGAL:**—Bengal Secretariat Book Depot, Writers' Buildings, Room No. 1, Ground Floor, Calcutta.  
**UNITED PROVINCES OF AGRA AND OUDH:**—Superintendent of Government Press, United Provinces of Agra and Oudh, Allahabad.  
**PUNJAB:**—Superintendent, Government Printing, Punjab, Lahore.  
**BURMA:**—Superintendent, Government Printing, Burma, Rangoon.  
**CENTRAL PROVINCES AND BEAR:**—Superintendent, Government Printing, Central Provinces, Nagpur.  
**ASSAM:**—Superintendent, Assam Secretariat Press, Shillong.  
**BHARAT AND ORISSA:**—Superintendent, Government Printing, Bihar and Orissa, P. O. Galsarbagh, Patna.  
**COORG:**—Office of the Chief Commissioner of Coorg, Bangalore.  
**NORTH-WEST FRONTIER PROVINCE:**—Manager, Government Printing and Stationery, Peshawar.

Thacker Spink & Co., Calcutta and Simla.  
W. Newman & Co., Ltd., Calcutta.  
R. Cantray & Co., Calcutta.  
S. K. Lahiri & Co., Calcutta.  
The Indian School Supply Depot, 309, Bow Bazar Street, Calcutta.  
Butterworth & Co. (India), Ltd., Calcutta.  
Rai M. C. Sarker Bahadur & Sons, 90-92A, Harrison Road, Calcutta.  
Standard Literature Company, Limited, Calcutta.  
Association Press, Calcutta.  
Chatterjee, Chatterjee & Co., Ltd., 13, College Square, Calcutta.  
The Book Company, Calcutta.  
James Murray & Co., 12, Government Place, Calcutta. (For Meteorological Publications only.)  
Ray Chaudhury & Co., 68-5, Ashutosh Mukerji Road, Calcutta.  
Scientific Publishing Co., 9, Taitola Lane, Calcutta.  
Chatterjee & Co., 214, Torowalla Street, Calcutta.  
B. C. Basak Esq., Proprietor, Albert Library, Dacca.  
Mittra Brothers, Rajshahi.  
Higginbothams, Madras.  
P. K. Rama Iyer & Co., Madras.  
Kochouse and Sons, Madras.  
G. A. Nateson & Co., Publishers, George Town, Madras.  
Theosophical Publishing House, Adyar, Madras.  
Bright & Co., Trivandrum.  
The Booklover's Resort, Trivandrum, South India.  
E. M. Gopalakrishna Kone, Pudukmandapam, Madurai.  
Central Book Depot, Madurai.  
Vijapur & Co., Vizagapatam.  
Thacker & Co., Ltd., Bombay.  
D. B. Taraporevala, Sons & Co., Bombay.  
Sunder Pandurang, Bombay.  
Ram Chandra Govind & Sons, Kalbadevi Road, Bombay.  
N. M. Tripathi & Co., Booksellers, Princes Street, Kalbadevi Road, Bombay.  
New & Secondhand Bookshop, Kalbadevi Road, Bombay.  
Mrs. Radhabai Atmaram Sagoo, Kalbadevi Road, Bombay.  
A. H. Wheeler & Co., Allahabad, Calcutta and Bombay.  
S. Govind & Co., Sandhurst Road, Girgaum, Bombay.  
Proprietor, New Kitabkhana, Poona.  
The Manager, Oriental Book Supplying Agency, 15, Shukrawar, Poona City.  
Rama Krishna Bros., Opposite Vishrambag, Poona City.  
S. K. Bookstall, 21, Puthwar, Poona.  
Margaldas & Sons, Booksellers and Publisher, Hazra Talao, Surat.  
T. The Standard Book and Stationery Co., 32-33, Artab Road, Peshawar.

R. B. Umadkar & Co., The Bharat Book Depot, Dharwar.  
The Standard Bookstall, Karachi, Quetta, Delhi, Murree and Rawalpindi.  
The Karachi Book Depot, Elphinstone Street, Camp, Karachi.  
The English Bookstall, Karachi.  
The Standard Bookstall, Quetta.  
U. P. Malhotra & Co., Quetta.  
J. Ray & Sons, 43, K. & L. Edwardes Road, Rawalpindi, Murree and Lahore.  
The Standard Book Depot, Lahore, Nainital, Jaunsar, Dainousie, Amhala Cantonment and Delhi.  
N. B. Mathur, Supdt., Nazir Kanun Hind Press, Allahabad.  
The North India Christian Tract and Book Society, 18, Olive Road, Allahabad.  
Ram Dayal Agarwala, 164, Katra, Allahabad.  
The Indian Army Book Depot, Jubb, Cawnpore.  
The Indian Army Book Depot, Jullundur City.  
Manager, Newal Kishore Press, Lucknow.  
The Upper India Publishing House, Ltd., Literature Palace, Anandmulla Park, Lucknow.  
Rai Sahib M. Gulab Singh & Sons, Mudd-I-Am Press, Lahore and Allahabad.  
Rama Krishna & Sons, Booksellers, Anarkali, Lahore.  
Puri Brothers, Booksellers and Publishers, Kutchai Road, Lahore.  
The Tilak School Bookshop, Lahore.  
The Standard Bookstall, Lahore.  
The Proprietor, Punjab Sanskrit Book Depot, Saldimla Street, Lahore.  
The Insurance Publicity Co., Ltd., Lahore.  
The Punjab Religious Book Society, Lahore.  
Manager of the Imperial Book Depot, 63, Chandni Chowk Street, Delhi.  
Feroz Book Agency, New Delhi.  
Oxford Book and Stationery Company, Delhi.  
Supdt., American Baptist Mission Press, Rangoon.  
The Modern Publishing House, Ltd., 30, Phayre Street, Rangoon.  
Burma Book Club, Ltd., Rangoon.  
Manager, The "Hitavada," Nagpur.  
Bhisey Brothers, Booksellers and Stationers, Sitabai, Nagpur.  
S. C. Talukdar, Proprietor, Students & Co., Cooh Behar.  
The Manager, Ceylon Observer, Colombo.  
The Manager, The Indian Book Shop, Benares City.  
The Srivilliputtur Co-operative Trading Union, Ltd., Srivilliputtur (S. I. R.).  
Raghunath Prasad & Sons, Patna City.  
The Students' Emporium, Patna.  
E. L. Mathur & Bros., Gorri, Patna City.  
Dandekar Brothers, Indore City.  
Pustakalaya Sahayak Sahakari, Ltd., Baroda.  
The Hyderabad Book Depot, Chaderghat, Hyderabad (Deccan).  
Thakur & Co., Amritsar.

# CONTENTS

	PAGE.
I. DESCRIPTION OF <i>Dipylidium catus</i> n. sp. . . . .	1
II. A NOTE ON SPECIATION IN THE GENUS <i>Dipylidium</i> LEUCKART, 1863 . . . .	4
III. SYSTEMATIC CONSIDERATION OF THE GENUS <i>Dipylidiosis</i> LEUCKART, 1863 . .	8
IV. ACKNOWLEDGMENTS . . . . .	13
V. REFERENCES . . . . .	13



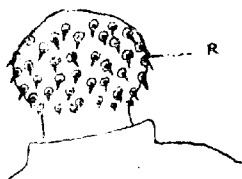
Description of a New Species of Tapeworm,  
*Dipylidium catus*, n. sp.  
with  
A Note on the Genus *Dipylidium* Leuckart,  
1863.

(Received for publication on the 9th October 1928.)

**I. Description of *Dipylidium catus* n. sp.**

A pure bred Siamese cat (the property of Mr. Hearsey, Farm Manager, Muktesar), born and brought up in Almora (Kumaon), United Provinces, India, and suffering from suspected tuberculosis, was submitted to *post-mortem* examination on 10th June, 1925, at this Institute, but no lesion of this disease could be detected. The writer was given the opportunity to examine the intestines of the animal for parasitic helminths, when over 500 specimens of a tiny species of tapeworm, and a single *Ascarid* specimen, were collected. The following description of the former parasite was worked out.

The worm measures 28 to 40 mm. in length consisting of 30 to 40 proglottids. The head is globular and distinctly marked off from the rest of the body. There is a small unsegmented neck which is only slightly narrower than the head. The worm gradually broadens pos-



Camera lucida drawing of rostellum and hooks  $\times 200$ .

teriorly; the segments, which are broader than long to begin with, gradually increase in length and become longer than broad in mature and gravid segments, when they measure 3 to 4 mm.  $\times$  0.6 to 1.5 mm. Measurements of other parts are:—

*Head.* 0.35 to 0.44 mm. broad, and 0.35 to 0.6 mm. long (including extended rostellum but not neck); when the rostellum is withdrawn, the head measures 0.27 to 0.42 mm. long.

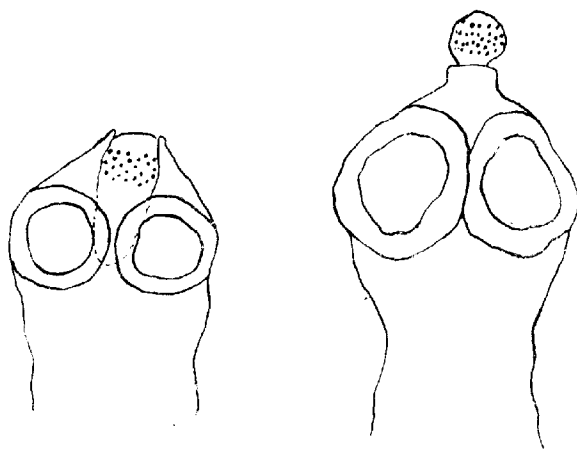
*Rostellum.* 0.08 mm. to 0.12 mm. long, and 0.08 mm. broad (in the widest portion).

*Anterior segment.* 0.04 mm. long and 0.35 mm. broad.

*Mature segments.* 1.5 to 2.5 mm. long and 0.35 to 0.6 mm. broad.

*Gravid segments.* 3 to 4 mm. long and 0.6 to 1.5 mm. broad.

The suckers are rounded and are provided with circular cup-like excavations, but they assume an elliptical form in contracted specimens. The rostellum is short, and in an extended condition roughly resembles



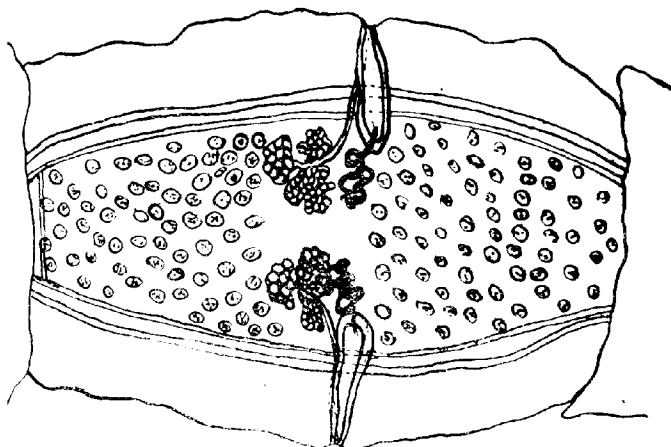
Camera lucida drawing of head showing withdrawn rostellum  $\times$  60.

Camera lucida drawing of head showing extended rostellum  $\times$  60.

the knob of a handle but in its retracted condition it may sometimes present the general appearance of a blunt cone. The knobbed or globular portion is covered with five to six alternating rows of hooks, which

are typically shaped like rose thorns. The size of the hook gradually decreases from front backwards, the largest measured being 12 microns and the smallest 6 microns. The total number of hooks varies from 50 to 60.

Each segment has a pair of longitudinal excretory canals on each side. The genital pores, located anterior to the middle or sometimes in the middle of the lateral margin in mature segment, and always anterior to the middle in the unripe segments, are not prominent. The testes in mature segments are 120 to 150 in number lying always between



Camera lucida drawing of a mature segment showing internal morphology  $\times 40$ .

the excretory canals anterior and posterior to the rest of the genitalia. The vas deferens is coiled and runs posteriorly and centrally. The cirrus pouch is much elongated, is deflected towards the anterior, and extends one-third to one-half of its length across the longitudinal excretory canals and measures 0.25 to 0.3 mm. in length. The ovaries are in two lobes, one on each side of the oviduct and the inner lobe is larger than the other lobe, each of these lobes being composed of distinct lobules. The vitellarium is slightly smaller than the ovary and is composed of distinct lobules which present the appearance of a bunch of grapes. The eggs lie in groups of 2 to 13 in each egg-capsule. The

egg-capsules are not densely packed in gravid segments and do not extend beyond the longitudinal excretory canals.

As the species described in this paper differs in certain essential characters from the species of *Dipylidium* hitherto recorded, the writer proposes for it the name *Dipylidium catus*.

*Definition of Dipylidium catus.* Length 28 to 40 mm. and maximum width 1.5 mm. Rostellum bears 5 to 6 rows of rose-thorn-shaped hooks, and is conical or knobbed. Genital pore anterior to the middle or middle of the lateral margin of segments. Testes 120 to 150 in number. Ovaries slightly larger than the vitellarium. Cirrus pouch extends one-third to one-half of its length across the excretory vessels. Egg-capsules contain 2 to 13 eggs. Habitat: duodenum of Siamese cat (*Felis domestica*). Locality: Muktesar, U. P. India.

## II. A Note on Speciation in the Genus *Dipylidium* Leuckart, 1863.

A comparative study of more important morphological characters, that have been used by previous writers for the erection of new species in the genus *Dipylidium*, has been made by the writer in their application to five species of *Dipylidium*, namely:—*D. caninum*, *D. oerleyi*, *D. sezecoronatum*, *D. walkeri* and *D. catus*. In the case of the genus *Strongyloides*, specificity of the host has been regarded by Sandground (1925) as the best indication of the specific identity of a parasite, and a cross infection test, the most reliable means to confirm the diagnosis. This would however appear to fail in the case of the genus *Dipylidium*, where a single species is known to occur in more than one species of host, such as one finds in the case of *D. caninum* which occurs in dog, cat and man, whilst two or more species may be harboured by the same species of host, as is illustrated in the case of *D. caninum*, *D. sezecoronatum*, and *D. walkeri*, all of which occur in the dog. In the case of digenetic cestodes, a study of their life-histories may provide a basis for specific determination, but the labour involved in following the developmental processes undergone by digenetic tapeworms in their invertebrate hosts is likely to be enormous, and observations are likely to be prolonged over a great length of time for the determination of intermediate hosts alone. Concluding from the observations of the writer on five species in his collection, namely, *D. caninum*, *D. oerleyi*, *D. sezecoronatum*, *D. walkeri*, and *D. catus*, an attempt is made below to adjudge the relative value of such characters as have been hitherto employed for diagnostic purposes. These characters are the total length, numbers of rows of hooks, length of cirrus sac, distribution of egg-capsules and the number of eggs in each capsule, number and distribution of testes, shape of vitellarium and position of genital pore.



Diagrammatic sketch of the entire tapeworm  $\times 9$ .

## (A) TOTAL LENGTH.

The greatest length recorded for *Dipylidium* would appear to have been in the case of a *D. caninum*, namely, 40 cm. ranging from a minimum length of 15 cm., but complete specimens collected at Muktesar never measured more than 20 cm., nor less than 10 cm. The size of worms is subject to variation on account of age, damage, the medium employed for fixation and preservation, and the conditions under which they develop in their normal habitat. *D. walkeri*, *D. sezecronatum*, and *D. oerleyi* measure 10 to 28, 10 to 23.5, and 5 to 11 cm., respectively. The first two species are thus very near each other in length, whilst the maximum length of *D. oerleyi* places it near either of the other two species. It, however, offers itself as a dependable character for marking off relatively small species like *D. catus* and *D. buencaminoi* (which do not exceed 4 mm. in length), from the other four species referred to above.

## (B) NUMBER OF ROWS OF HOOKS.

In the case of the genera *Tania* and *Multiceps*, *t* is the number of hooks that has been regarded as of importance in specific diagnosis, whereas in the case of the genus *Dipylidium*, workers have largely relied upon the number of circlets and rows of hooks—perhaps on account of the fact that this has been considered simpler than the counting of individual hooks. Experience has shown, however, that the disposition of the alternate rows of hooks in individual specimens is liable to considerable variation on account of (1) Loss of some hooks in the process of detachment from the host; (2) some hooks having been shed owing to the parasites being kept too long in salt solution, before fixation, or the host having died long before the collection of the specimens; (3) contraction of rostellum in longitudinal direction and the consequent shortening of the initial distance between consecutive rows of hooks or its contraction in the transverse direction, bringing two alternate rows in closer proximity and sometimes practically in one line. In view of such errors as would be liable to occur on account of the last two possibilities, the total number of hooks would appear to be a better guide in diagnostic work than the number of rows.

## (C) LENGTH OF CIRRHUS SAC.

The fact whether this organ extends up to or across the excretory canals has been regarded as an indication of the specific position of an individual, but in the course of the study of the five species mentioned above, slight variations in this respect have been observed in different segments of the same individual or in different individuals of the same

pecies, such misleading variations being probably brought about as a result of contraction in strong fixatives or extension or lengthening of the worms on keeping them too long in saline (as a first step towards degeneration). The actual length of the cirrus sac itself has appeared to the writer to constitute a better character in specific diagnosis.

(D) DISTRIBUTION OF EGG-CAPSULES AND THE NUMBER OF EGGS IN A CAPSULE.

The distribution of egg-capsules depends upon the relative egg-producing power of the individual segment. The egg-capsules in gravid segments extend beyond the excretory canal in *D. caninum*, *D. oerleyi*, and *D. sexcoronatum*, but are limited by the canals in *D. walkeri* and *D. catus*. It is interesting to note in this connection that in the case of two specimens of *D. caninum* the egg-capsules in the cortical portion, lying beyond the excretory canals, had been passed before those in the medullary portion, as was evidenced by the fact that the last gravid segment of the strobilus in some of these specimens had no egg-capsules in the cortical portion but had some in the medullary portion, while the penultimate segment was found packed tightly upto its very boundary wall.

The number of eggs in egg-capsules has been found to vary considerably by various workers, the variation observed being perhaps due to the fact that counts have always been made while the egg-capsules were inside the gravid segment, and so represented all stages from their early development to complete maturity. In the case of *D. catus*, an examination of the intestinal contents of the host showed that all the 15 specimens of egg-capsules encountered had a constant number of 13 eggs in them. The maximum number counted from transverse sections was also found to be 13. The eggs in a gravid segment varied from 14 to 20 microns in diameter.

(E) NUMBER AND DISTRIBUTION OF TESTES.

The large variation in the number of testes described by various authors for different species was also observed in the five species referred to above, the number of the testes increasing gradually from front backwards as far as the segments in which the egg-capsules begin to make their appearance. The distribution, however, may not be constant, as changes originating from contraction and spread of the uterine sac may drive the testes beyond the excretory canals, as has been noticed in the case of *D. walkeri*.

## (F) SHAPE OF VITELLARIUM.

This character is subject to considerable variation, such as has been described for various species ("irregular," "reniform," "like a bunch of grapes," "composed of minute follicles," etc.). A similar variation has been observed in different segments of the same individual in all the five species studied. An irregular appearance was noticed in transitional segments between mature and gravid segments. Vitellaria of the shape of bunch of grapes were seen in mature segments, and in the case of *D. catus* the bunches appeared as composed of minute follicles, under the effect of fixative (formalin 5 per cent.). Reniform appearance was seen in immature segments.

## (G) POSITION OF THE GENITAL PORE.

This character shows the least amount of variability and appears to be fairly constant in mature and gravid segments although slight individual irregularities may on rare occasions be seen in some segments.

### III. Systematic consideration of the Genus *Dipylidium* Leuckart, 1863.

Beddard, in 1913, distinguished from the genus *Dipylidium* a new genus *Diplopylidium* on the basis of the female genital pore being located anterior to that of the cirrus sac or the male pore, and *Dipylidium zschokkei* (Hungerbuhler, 1910) is now included under Beddard's genus *Diplopylidium*. Skrjabin (1924) defined another new genus *Progygopylidium*, the head of which is armed with 3 to 4 rows of hooks; those of the first row are equipped with a handle (manubrium) and there is a basal discoidal portion, i.e., *Tania*-like hooks; the female opening is situated either anterior or ventral to, never behind, that of the cirrus sac; and the egg-capsules contain one egg each. In addition to the type species *P. nolleri*, the author regarded *D. trinchesei* from cat and *D. avicola* from birds as also members of this new genus. Lopez-Neyra,

In a recent publication, Lopez-Neyra (1927) lays stress on the following five characters in the systematic consideration of the genus *Dipylidium* :—

- (1) Reticulate uterus which may be (a) replaced by thick-walled capsules containing many eggs, (b) replaced by thin-walled capsules which ultimately break into single-egged capsules, or (c) replaced by simple reticular ranges which ultimately break into single-egged capsules;
- (2) crotchets, (a) *Tenia*-like, or (b) rose-thorn shaped;
- (3) testes which may be (a) not more than 90, or (b) more than 90°;
- (4) vagina, (a) posterior to cirrus pouch, or (b) ventral or anterior to cirrus pouch;
- (5) strobilus, (a) short slender, sexual pores in the anterior  $\frac{1}{2}$  of the segment, or (b) long and broad, sexual pores in the neighbourhood of the middle of lateral border of the segment.

however, thinks that the genus *Progygopylidium* is indistinguishable from *Diplopylidium* which also has a row of *Tenia*-like hooks. He creates another genus, *Joyeuxia* distinguishable from *Diplopylidium* by the anterior position of the genital pore, the testicles being less than 90 in number, and egg-capsules containing one egg only in ripe segments. The following is a key to the genera of the sub-family *Dipylinae* Stiles, 1896 :—

Hooks: All rose-thorn-shaped Vagina situated posterior to the male opening.	{ 1. Genital pore situated in the middle or behind the middle of the lateral border of a segment; eggs upto 20 in each capsule <i>Diplopylidium</i> , 2. Genital pore situated distinctly anterior to the middle of lateral border of a segment; one egg in each capsule
Hooks: Anterior row <i>Tenia</i> -like .	{ <i>Joyeuxia</i> , Vagina situated ventrally or anterior to the opening of cirrus; one egg in each capsule <i>Diplopylidium</i> .

A list of the species belonging to these three genera is given below.



List of the species of Genus *Joyeuxia* Lopez-Neyra, 1927.

No.	Species	Length of the strobilus in mm.	No. of hooks	Size of hooks in microns	No. of testes	No. of eggs in a capsule	Size of eggs in microns	Host	Distribution
1	<i>J. chyeri</i> (Diamare, 1892)	120-200	12-14	14-5	45-50	1	52-58	<i>Felis catus domestica</i>	Hungary, Spain, Algeria, East Africa.
2	<i>J. paquetae</i> (Diamare, 1892)	20-30	16	7-8	50-66	1	64-67	<i>Felis catus domestica</i> ; <i>Canis familiaris</i> .	Egypt and Spain.
3	<i>J. echinorhynchoides</i> (Sonuluo, 1889)	26	16-25	16-5	50	1	..	<i>Megadontia corda</i> ; <i>Vulpes alpestris</i> ; <i>Felis catus domestica</i> .	North Africa.
4	<i>J. perrenies</i> (Setti, 1892)	10-40	10	10	60-70	1	..	<i>Oncocerca tigrina</i> ; <i>O. onca</i> ; <i>Zibellianus riverina</i> ; <i>Paradonurus hermaphroditicus</i> .	North Africa and India.
5	<i>J. fulvmani</i> (Euer, 1924)	30	14-16	?	40-50	1	..	<i>Zibellianus erici</i> ; <i>Felis concolor</i> .	South Africa.

NOTE: *J. sp.* (Kolani, 1917) is regarded by Euer (1924) as identical with *J. fulvmani*. Kolani recorded this species from *Felis capensis philipsi*.

List of the species of Genus *Diplopygidium* (Beddard, 1913), Lopez-Neyra, 1927.

No.	Species	Length of strobiling in mm.	No. of rows of hooks	Size of hooks in microns	No. of testes	No. of eggs per capsule	Size of eggs in microns	Hosts	Distribution
1	<i>D. trindleri</i> (Damaso, 1902)	23	4	47-60 and 36	25-32	1	46-52	<i>Felis catus dom.</i>	Europe.
2	<i>D. triseriale</i> (Lübke, 1896)	23	3	63-89 and 38-43	?	1	..	<i>Vicerra chetia</i> ; <i>Genetta afra</i>	Tunis; India.
3	<i>D. monophorum</i> (Lübke, 1896)	10	3	30-3 and 20	..	1	..	<i>Vicerra chetia</i> ; <i>Genetta afra</i>	Tunis; Algeria.
4	<i>D. echinobos</i> (Führmann, 1906)	..	4	45-88	..	1	30	<i>Columba</i> sp.	....
5	<i>D. zachvatzi</i> (Hungerbühler, 1910)	120	3	46-17	30	1	30-40	<i>Cynictis penicillata</i>	South Africa.
6	<i>D. eudiplopygidium</i> (Lopez-Neyra and Muñoz, 1921)	32-65	5	68-71 and 13	46-68	1	33-34	<i>Felis catus dom.</i>	Spain.
7	<i>D. genetta</i> (Beddard, 1913)	..	2	?	Many testes.	1	..	<i>Genetta douglasae</i>	....
8	<i>D. walleri</i> (Skrjabin, 1924)	..	3-4	53-48 and 10	12-16	1	?	<i>Felis catus dom.</i>	....

#### IV. Acknowledgments.

The writer has pleasure in expressing his grateful thanks to the following gentlemen :—

- (1) Dr. J. T. Edwards and Mr. A. J. Turner for encouragement and facilities.
- (2) Messrs. F. Ware, V. R. Phadke and Director, Hatkine Institute, Bombay, for the loan of valuable references.
- (3) Mr. H. Cooper for his criticism of the text.
- (4) Mr. T. N. Rao for translating for him a German reference.

Special mention of Mr. S. K. Sen's help in bringing the paper in its present form is also made with gratitude.

#### V. References.

- (1) Baer, J. G. (1926). Contributions to the Helminth Fauna of South Africa. Mammalian cestodes. *11th and 12th Report of the Director of Veterinary Education and Research* (Union of South Africa), Part I.
- (2) Beddard, F. E. (1913). Contributions to the anatomy and systematic arrangement of the cestodea. No. X. On two new species of tapeworms from *Genneta dongolana*. *Proc. Zool. Soc. London*, pp. 549-571.
- (3) Hall, M. C. (1916-17). A synoptical key to the adult Taenoid cestodes of the dogs, cats and related carnivores. *Jl. Amer. Vet. Med. Assoc.*, Vol. 50, pp. 356-360.
- (4) Hall, M. C. (1919). The adult Taenoid cestodes of dogs, cats and related carnivores in North America. *Proc. U. S. Nat. Museum*, Vol. 55, pp. 1-94.
- (5) Lopez-Neyra, C. R. (1927). Considerations Sur Le Genre *Dipylidium*, Leuckart. *Bull. Soc. Path. Exot.*, Vol. 20, No. 5, pp. 434-440.
- (6) Meggitt, F. J. (1924). *The Cestodes of Mammals*, London, pp. 62-64.
- (7) Millner, Th. M. (1926). On the cestode genus *Dipylidium* from cats and dogs. *Univ. Calif. Pub. in Zoology*, Vol. 28, No. 17, p. 317.
- (8) Neveu-Lemaire, M. (1912). *Parasitologie des animaux domestiques*. Paris, p. 485.
- (9) Sandground, J. H. (1925). Speciation and specificity in the nematode genus *Strongyloides*. *Jl. Parasitology*, Vol. 12, No. 2, pp. 59-80.

- (10) Skrjabin, K. I. (1924). *Progyxopygidium nolleri* Nov. gen., nov spec., ein neuer Bandwurm der Katze. *Berl. Tierarztl. woch.*, No. 32, Vol. 40, pp. 420-422.
- (11) Sondhi, G. (1923). Tapeworm parasites of dog in the Punjab. *Parasitology*, Vol. 15, pp. 59-66.
- (12) Tuhangui, M. A. (1925). Metazoon Parasite of Philippine Domesticated Animals. *Philipp. Jl. Scie.*, Vol. 28, No. 1, pp. 18-19.

# PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

TO BE HAD FROM

THE MANAGER, GOVERNMENT OF INDIA CENTRAL PUBLICATION BRANCH, IMPERIAL  
SECRETARIAT BUILDING, 3, GOVERNMENT PLACE, WEST, CALCUTTA;

THE OFFICE OF THE AGRICULTURAL ADVISER TO THE GOVERNMENT OF  
INDIA, PUSA, BIHAR;

AND

ALL AGENTS FOR SALE OF GOVERNMENT PUBLICATIONS.

A complete list of the publications of the Imperial Department of Agriculture in India can be obtained on application from the above-mentioned.

These publications are:—

1. *The Agricultural Journal of India.* A Journal dealing with subjects connected with agricultural economics, field and garden crops, economic plants and fruits, soils, manures, methods of cultivation, irrigation, climatic conditions, insect pests, fungus diseases, co-operative credit, farm implements, and other agricultural matters in India. Illustrations, including coloured plates, form a prominent feature of the Journal. It is edited by the Agricultural Adviser to the Government of India, and is issued once every two months or six times a year. *Annual subscription*, Rs. 6 or 9s. 6d. including postage. Single copy, Re. 1-8 or 2s.
2. *The Journal of the Central Bureau for Animal Husbandry and Dairying in India.* A quarterly dealing with cattle-breeding, dairying, cultivation and storage of fodder crops, animal nutrition, and other aspects of animal husbandry. It is edited by the Agricultural Adviser to the Government of India. *Annual subscription*, Rs. 2-8. Single copy, As. 10.
3. Scientific Reports of the Agricultural Research Institute, Pusa.
4. Review of Agricultural Operations in India.
5. Proceedings of the Board of Agriculture in India.
6. Proceedings of Sectional Meetings of the Board of Agriculture.
7. Memoirs of the Imperial Department of Agriculture in India.
  - (a) Botanical Series.
  - (b) Chemical Series.
  - (c) Entomological Series.
  - (d) Bacteriological Series.
  - (e) Veterinary Series.

8. Bulletins issued by the Agricultural Research Institute, Pusa.
9. Books.

The following are the publications of the last two years:—

- Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, the Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), for the year 1926-27. Price, Rs. 1-14 or 3s. 3d.
- Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), for the year 1927-28. Price, Rs. 2-6 or 4s. 3d.
- Review of Agricultural Operations in India, 1925-26. Price, Rs. 2-6 or 4s. 3d.
- Review of Agricultural Operations in India, 1926-27. Price, Rs. 2 or 3s. 6d.
- Proceedings of the Board of Agriculture in India, held at Pusa on 7th December, 1925, and following days (with appendices). Price, Rs. 1-14 or 3s. 3d.

## MEMOIRS OF THE DEPARTMENT OF AGRICULTURE IN INDIA

### Botanical Series

- Vol. XIV, No. IV. Studies in Gujarat Cottons, Part IV; Hybrids between Broach-deshi and Goghari varieties of *Gossypium herbaceum*, by M. L. PATEL, M.A., and S. J. PATEL, B.A.G. Price, As. 14 or 1s. 6d.
- Vol. XIV, No. V. The Indigenous Cotton Types of Burma, by T. D. STOOK, B.Sc., D.I.C., A.R.C.S. Price, As. 9 or 10d.
- Vol. XIV, No. VI. A Study of *Fusaria* common to cotton plants and cotton soils in the Central Provinces, by JIWAN SINGH, M.Sc. Price, As. 5 or 6d.
- Vol. XIV, No. VII. The Kolamba Rice of the North Konkan and its Improvement by Selection, by R. K. BHIDE and S. G. BHALERAO, B.A.G. Price, Re. 1-4 or 2s.
- Vol. XIV, No. VIII. *Pennisetum typhoides*: Studies on the Bajri crop. 1. The Morphology of *Pennisetum typhoides*, by S. V. GODBOLE, M.Sc., B.A.G. Price, As. 12 or 1s. 3d.
- Vol. XV, No. I. Studies in Khandesh Cotton, Part I, by S. H. PRAYAG, M.A.G. Price, Re. 1-4 or 2s. 3d.
- Vol. XV, No. II. The Indian Types of *Lathyrus sativus* L. (Khesari, Lakh, Lang, Teora), by GABRIELLE L. C. HOWARD, M.A., and K. S. ABDUR RAHMAN KHAN. Price, Re. 1-8 or 2s. 6d.
- Vol. XV, No. III. Fruit-Rot Disease of Cultivated Cucurbitaceae caused by *Phythium aphanizematum* (Eds.) Fitz., by M. MITRA, M.Sc., F.L.S., and L. S. SUBRAMANIAM, F.L.S. Price, As. 6 or 8d.
- Vol. XV, No. IV. Colour Inheritance in Rice, by S. K. MITRA, M.Sc., Ph.D., and S. N. GUPTA and P. M. GANGULI. Price, As. 6 or 8d.
- Vol. XV, No. V. *Asterina* spp. from India determined by DR. RUTH RYAN and *Meliola* spp. from India and one from Malay determined by Prof. F. L. STEVENS. Price, As. 4 or 5d.
- Vol. XV, No. VI. Studies on Rice in Sind, Part I, by K. I. THADANI, M.Sc., and H. V. DURGA DUTTA, B.Sc. Price, Re. 1 or 1s. 9d.
- Vol. XV, No. VII. Variability in certain economic characters particularly in seed weight and weight of lint per seed in pure strains of Broach Deshi Cotton, by MAGANLAL L. PATEL, M.A.G., and HAROLD H. MANN, D.Sc. Price, As. 14 or 1s. 6d.
- Vol. XV, No. VIII. Studies in the Shedding of Mango Flowers and Fruits, Part I, by P. V. WAGLE, M.A.G. Price, As. 11 or 1s. 3d.
- Vol. XVI, No. I. Studies in the *Jowars* of Gujarat: I. The *Jowars* of the Surat District, by M. L. PATEL, M.A.G., and G. B. PATEL, B.A.G. Price, Re. 1-6 or 2s. 3d.
- Vol. XVI, No. II. Studies in Indian Chillies, I: The Types of Capsicum, by F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S., and Khan Sahib ABDUR RAHMAN KHAN. Price, Re. 1-8 or 2s. 6d.
- Vol. XVI, No. III. Foot-rot and wilt of *Antirrhinum* caused by *Phytophthora pini* var. *auritricha* n. v., by S. SUNDARARAMAN, M.A., and T. S. RAMAKRISHNAN, M.A. Price, Re. 1 or 1s. 9d.
- Vol. XVI, No. IV. Further studies of Indian Grasses and Grass-lands, by W. BURNS, D.Sc. (Edn.), L. B. KULKARNI, M.A.G. (Bom.), and S. R. GODBOLE, B.Sc. (Bom.) Price, Re. 1-4 or 2s. 3d.
- Vol. XVI, No. V. Studies of Sugarcane roots at different stages of growth, by RAO BAHADUR T. S. VENKATRAMAN, B.A., and R. THOMAS. Price As. 13 or 1s. 6d.
- Vol. XVI, No. VI. Studies in Indian Pulses: I. Lentil (*Ervum lens* Linn.), by F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S., and RAHMAT DAS ROSE, B.Sc. Price, Re. 1-10 or 2s. 6d.
- Vol. XVI, No. VII. *Pythium aphanizematum* (Eds.) Fitz. on *Opuntia Dillenii*, Haw., by T. S. RAMAKRISHNA AYYAR, M.A. Price, As. 8 or 10d.
- Vol. XVII, No. I. Non-dehiscence of anthers in Punjab American Cottons by TREVOR TROUGHTON, M.A. Price, As. 4 or 5d.
- Vol. XVII, No. II. Studies in the Wilt Disease of Cotton in the Bombay Kanatak, Series I, by G. S. KULKARNI, M.A.G., and B. B. MUNDEBH, M.A.; with an introduction by DR. H. H. MANN. Price, As. 9 or 1s.

### Chemical Series

- Vol. IX, No. III. Some Digestibility Trials on Indian Feeding Stuffs, II, by P. E. LANDER, M.A. D.Sc., A.I.C., and PANDIT LAL CHAND DHARMANI, L.A.G., B.Sc. (Ag.) Price, As. 10 or 1s.
- Vol. IX, No. IV. The Effect of Manuring a Crop on the Vegetative and Reproductive Capacity of the Seed, by B. VISWANATH, F.L.C., and M. SURIANARAYANA, B.Sc. Price, As. 14 or 1s. 6d.
- Vol. IX, No. V. Experiments on the Feeding of Sorghum silage and concentrate to Sindhi calves, by F. J. WARTH, M.Sc., and SHARI KANT MISRA. Price, As. 9 or 10d.

### Chemical Series—contd.

- Vol. IX, No. VI. Losses and gains of Nitrogen in an Indian Soil studied in relation to the seasonal composition of well waters, and the bearings of the results on the alleged deterioration of soil fertility, by HAROLD K. ANNETT, D.Sc., F.I.C., M.S. B.A.O., A. PADMANABHA AYYAR, B.A., and RAM NARAYAN KAYASTH, M.Sc., B.A.G. Price, Rs. 2 or 3s. 6d.
- Vol. IX, No. VII. Some Digestibility Trials on Indian Feeding Stuffs, Part III: Some Punjab Hays, by P. E. LANDER, M.A., D.Sc., A.I.C., and PANDIT LAL CHAND DHARMANI, L.A.G., B.Sc. (Ag.). Price, As. 5 or 8d.
- Vol. IX, No. VIII. The determination of the Electrical Conductivity of the aqueous extract of Soil as a rapid means of detecting its probable Fertility, by ASHUTOSH SEN, M.Sc. Price, As. 4 or 6d.
- Vol. X, No. I. Feeding Experiments at Karnal, by F. J. WARTH, M.Sc., and F. J. GOSSIP. Price, As. 8 or 10d.
- Vol. X, No. II. Soils of the Punjab, by DR. P. E. LANDER, M.A., D.Sc., A.I.C., DR. RAMJI NARAIN, D.Sc., and MRHTA MOKAND LAL, B.Sc., L.A.G. Price, Rs. 3-14 or 6s. 9d.

### Entomological Series

- Vol. X, Nos. I. & II. Four New Indian Gall Midges, by DR. E. P. FELT, The Citrus Psylla (*Diuraphis citri*, Kuw.), by M. AFZAL HUSAIN, M.Sc., M.A. Price, Rs. 1-2 or 2s.
- Vol. X, No. III. Braconidae Vipaninae of South India, by T. V. RAMAKRISHNA AYYAR, B.A., F.R.S., F.Z.S. Price, As. 14 or 1s. 3d.
- Vol. X, No. IV. Some New Indian Miridae (*Carpidae*), by E. BALLARD, B.A., F.R.S. Price, As. 6 or 8d.
- Vol. X, No. V. The Use of Hydrocyanic Acid Gas for the Fumigation of American Cotton on import into India. Experiments on its lethal power for the Mexican Boll-weevil (*Anthonomus grandis*) and for the Grain-weevil (*Sitophilus oryzae*); on the extent to which it is absorbed by Cotton and Jute respectively; and on a practical method for satisfactory fumigation on a large scale, by A. JAMES TURNER, M.A., B.Sc., and D. L. SEY, M.Sc. TECH., M.Sc., with a Foreword by B. C. BERR, M.B.E., B.Sc. Price, Rs. 2 or 3s. 9d.
- Vol. X, No. VI. Studies on *Platyedra gossypiella*, Saunders (Pink Bollworm) in the Punjab, by SOHAN SINGH BINDRA, M.Sc. Price, Rs. 1-4 or 2s. 3d.
- Vol. X, No. VII. A Contribution to our knowledge of the Thysanoptera of India, by T. V. RAMAKRISHNA AYYAR, Ph.D., F.R.S., F.Z.S. Price, Rs. 1-9 or 2s. 6d.
- Vol. XI, No. I. A List of the Generic Names used for Microlepidoptera, by T. BAINEBRIDGE FLETCHER, B.N., F.L.S., F.E.S., F.Z.S. (In the press.)

### Bacteriological Series

- Vol. II, No. II. A Bacterial Soft Rot of Garden Peppery, by C. S. RAM AYYAR, B.A. Price, As. 5 or 6d.
- Vol. II, No. III. Nitrification of Calcium Cyanamide in some Indian Soils, by J. H. WALTON, M.A., M.Sc. Price, As. 10 or 1s.

### Veterinary Series

- Vol. IV, No. I. The Chemotherapy of Surra (*Trypanosoma Evansi* Infections) of Horses and Cattle in India, by J. T. EDWARDS, D.Sc., M.R.C.V.S. Price, Rs. 4-2 or 7s.
- Vol. IV, No. II. Studies in Bovine Lymphangitis, by V. KRISHNAMURTI AYYAR. Price, Rs. 1-2 or 2s.
- Vol. IV, No. III. Trypanblue and certain dithio-aniline derivatives: their efficacy in the treatment of Piroplasmosis and other affections in the Central Provinces, by Major R. F. STIRLING, F.R.C.V.S., D.V.S.M., F.Z.S., L.V.S. Price, As. 3 or 4d.
- Vol. IV, No. IV. Nasal Granuloma in Cattle in Bihar and Orissa, by RAI SANJIV P. N. Das. Price, As. 3 or 4d.

### Bulletins issued by the Agricultural Research Institute, Pusa.

- No. 166. Sampling for Rice Yield in Bihar and Orissa, by J. A. HUBBARD, L.C.S. Price, As. 7 or 9d.
- No. 167. A Scheme of Classification of the Varieties of Rice Found in Burma, by R. A. BEALE. Price, As. 6 or 8d.
- No. 168. List of Publications on Indian Entomology, 1926 (compiled by the Offg. Imperial Entomologist and the Imperial Entomologist). Price, As. 10 or 1s.
- No. 169. The Stem-bleeding Disease of Aracanut (*Arca catechu*) caused by *Thickaripoeis paradoxa* Von Hon., by S. SUNDARARAMAN, M.A., C. KRISHNAN NAYAR and T. S. RAMAKRISHNAN, M.A. Price, As. 9 or 1s.
- No. 170. Seasonal Variations in the Germ Content of Milk at Pusa, by J. H. WALTON, M.A., M.Sc. Price, As. 6 or 8d.

**Bulletins issued by the Agricultural Research Institute, Pusa—*contd.***

- No. 171. The Improvement of Indian Wheat. A Brief Summary of the Investigations carried out at Pusa from 1905 to 1924, including an account of the new Pusa Hybrids, by ALBERT HOWARD, C.I.E., M.A., and GABRIELLE L. C. HOWARD, M.A. Price, As. 8 or 10d.
- No. 172. The Mechanical Analysis of Tropical Soils, by J. CHARLTON, M.Sc., F.I.C. Price, As. 3 or 4d.
- No. 173. Occurrence of Trichomonad Flagellates in the blood stream of Fowls, by HUGH COOPER, M.R.C.V.S., and AMAR NATH GULATI, M.Sc. Price, As. 3 or 4d.
- No. 174. Unit System for Farm Buildings, by G. S. HENDERSON, N.D.A., N.D.D. Price, As. 5 or 6d.
- No. 175. A Comparative Study of the methods of preparation of the Soil for the Mechanical Analysis, with a Note on the Pipette Method, by AMAR NATH PURI, Ph.D., and B. M. AMIN, B.A. Price, As. 4 or 5d.
- No. 176. A Method of increasing the Manurial Value of *Mahua* Cake, by N. D. VYAS, L.A.G. Price, As. 4 or 6d.
- No. 177. Root-rot and Sclerotial Diseases of Wheat, by L. S. SUBRAMANIAM, F.L.S. Price, As. 4 or 5d.
- No. 178. A Study of the Locular Composition in Cambodia Cotton, by V. RAMANATHAN, L.A.G. Price, As. 7 or 9d.
- No. 179. A Leaf Spot and Blight Disease of Onions, caused by *Alternaria palandui* nov. sp., by C. RANGASWAMI AYYANGAR. Price, As. 6 or 8d.
- No. 180. Stem-rot of Berseem, caused by *Rhizoctonia Solani* Kühn, by MD. TASLIM. Price, As. 5 or 9d.
- No. 181. Life History, Bionomics and Control of *Mytillocerus maculosus*, Desb. (Curculionidae Coleoptera), by KIDAR NATH TRIHAN, M.Sc. (*In the press.*)
- No. 182. Investigations in the Bacteriology of Silage (1926-27), by J. H. WALTON, M.A., M.Sc. Price, As. 5 or 6d.
- No. 183. A Milk Fermenting Yeast, by C. S. RAM AYYAR, B.A. Price, As. 5 or 6d.
- No. 184. List of Publications on Indian Entomology, 1927 (compiled by the Imperial Entomologist). Price, As. 6 or 9d.
- No. 185. The Cultivation of Lac in the plains of India, *Laccifera lacca*, Kerr., by C. S. MISRA, B.A. (Revised Edition.) (*In the press.*)
- No. 186. A Preliminary Note on the Rice crop in the United Provinces, by R. L. SETHI. Price As. 7 or 9d.
- No. 187. The Production of Cigarette Tobacco by Flue-Curing, by F. J. F. SHAW, D.Sc., A.R.C.S., F.L.S., and KASHI RAM. Price, Rs. 1 or 1s. 9d.
- No. 188. Designs for Farm Buildings, by G. S. HENDERSON, N.D.A., N.D.D. Price, As. 6 or 8d.
- No. 189. The Improvement of Kharwar-American Cotton by Hybridization, by R. K. KULKARNI, B.A., and T. R. KHADILKAR, B.A.G. Price, Rs. 2-2 or 4s.
- No. 190. Description of a New species, *Dipylidium catus* n. sp., with a Note on the Genus *Dipylidium* Leuckart, 1863, by AMAR NATH GULATI, M.Sc. Price, As. 6, or 8d.
- No. 191. Agricultural Implements and Machinery at Pusa, Part I: Cultivation Implements and Machinery, by G. S. HENDERSON, N.D.A., N.D.D. and ARJUN SINGH, L.A.G. (*In the press.*)
- No. 192. Agricultural Implements and Machinery at Pusa, Part II: Harvesting and Threshing Implements and Machinery, by G. S. HENDERSON, N.D.A., N.D.D., and ARJUN SINGH, L.A.G. (*In the press.*)
- No. 193. Agricultural Implements and Machinery at Pusa, Part III: Special and Miscellaneous Implements and Machinery, by G. S. HENDERSON, N.D.A., N.D.D., and ARJUN SINGH, L.A.G. (*In the press.*)
- No. 194. Agricultural Implements and Machinery at Pusa, Part IV: Power Implements and Machinery, by G. S. HENDERSON, N.D.A., N.D.D., and ARJUN SINGH, L.A.G. (*In the press.*)

**Books**

- Wheat in India, by ALBERT HOWARD, M.A., A.R.C.S., F.L.S., and GABRIELLE L. C. HOWARD, M.A. Price, Rs. 5 or 7s. 6d.
- A Description of the Imperial Bacteriological Laboratory, Muktesar: Its Work and Products, by MAJOR J. D. E. HOLMES, M.A., D.Sc., M.R.C.V.S. Price, As. 8 or 9d. Hindi and Urdu Editions, Rs. 2-4 each.
- Agriculture in India, by JAMES MACKENNA, M.A., L.C.S. Price, As. 4 or 5d.
- Some Diseases of Cattle in India. A Handbook for Stock-owners. (Revised in 1927.) Price, Rs. 14 or 2s.
- Report on the Diseases of Silkworms in India, by A. PRINGLE JAMESON, D.Sc. Price, Rs. 3.
- The Importance of Bacterial Action in Indigo Manufacture, by C. M. HUTCHINSON, B.A. Price, As. 2.

**Notice**

All new publications are included in the above list and are regularly posted to all on the mailing list as soon as issued. Unless complaints of non-receipt of any publication are received by the Manager, Government of India Central Publication Branch, Imperial Secretariat Building, 3, Government Place, West, Calcutta, within six months of the date of issue, duplicate copies can be supplied only on payment of cost and postage.

